SECTION 6
CONFIGURATION VERIFICATION AND AUDIT

QUESTIONS THIS SECTION WILL ANSWER	Para.
1. What is configuration verification?	6.1, 6.2, 6.2.1
2. How is the complete implementation of a change verified?	6.2.1
3. What is a configuration audit? How does an audit differ from verification?	6.1, 6.2,
4. How do audits and verification relate to such activities as ISO 9000 certifications?	6.2
5. What are the different types of configuration audits? What do they determine?	6.2.2.1, 6.2.2.2
6. What is the relative importance of the physical audit vs the functional audit?	6.2.2
7. When are configuration audits necessary? When are they not?	6.2.2.3
8. How detailed should an audit be?	6.3
9. What are the common elements in any audit process?	6.3
10. What are the roles, tasks, responsibilities of the Government, the contractor, and, if applicable the third party auditor?	6.3
11. What part do certifications play in the audit process?	6.3

6.1 Configuration Verification and Audit Activity.

The configuration verification and audit process includes:

- Configuration verification of the initial configuration of a CI, and the incorporation of approved engineering changes, to assure that the CI meets its requred performance and documented configuration requirements
- Configuration audit of configuration verification records and physical product to validate that a development program has achieved its performance requirements and configuration documentation or the system/CI being audited is consistent with the product meeting the requirements.

The common objective is to establish a high level of confidence in the configuration documentation used as the basis for configuration control and support of the product throughout its life cycle. Configuration verification should be an imbedded function of the contractor's process for creating and modifying the CI or CSCI. Validation of this process by the Government may be employed in lieu of physical inspection where appropriate.

As shown in **Figure 6-1**, inputs to the configuration verification and audit activity are:

- Configuration, status, and schedule information from status accounting,
- Approved configuration documentation (which is a productof the configuration identification process),
- The results of testing and verification,
- The physical hardware CI or software CSCI and its representation
- Manufacturing
- Manufacturing/build instructions and engineering tools, including the software engineering environment, used to develop, produce, test and verify the product

Successful completion of verification and audit activities results in a verified System/CI(s) and a documentation set that may be confidently considered a Product Baseline. It also results in a validated process to maintain the continuing consistency of product to documentation.

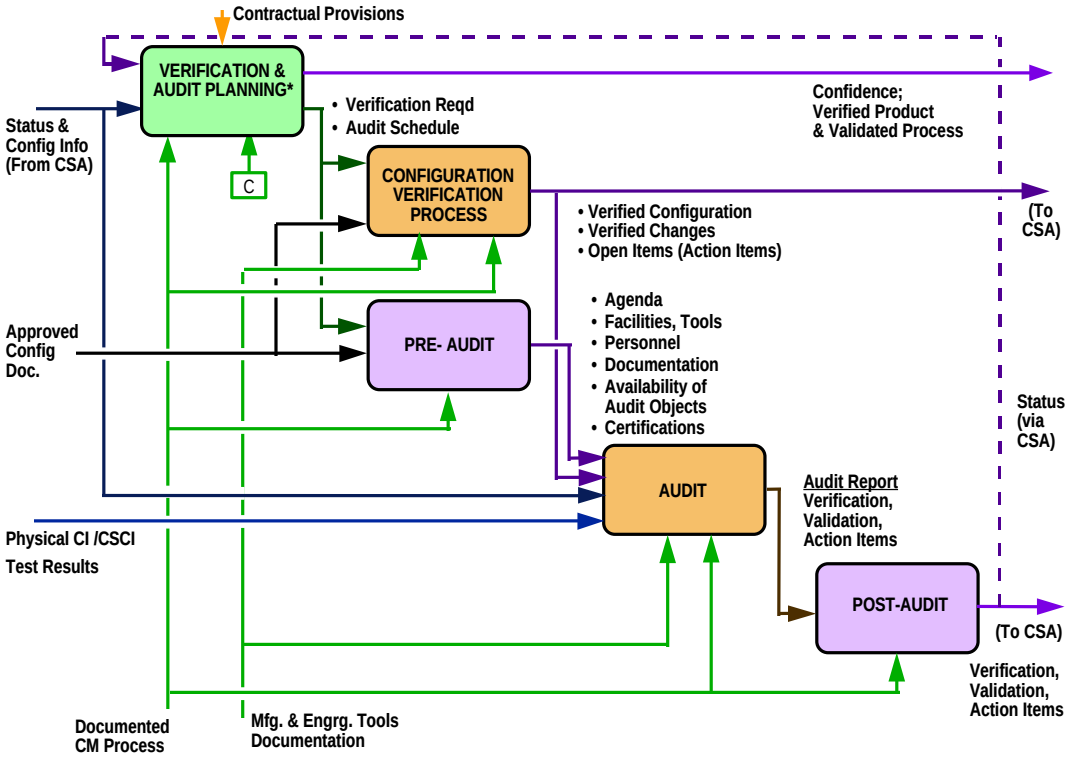

Figure 6-1. Configuration Verification and Audit Activity Model

6.2 Configuration Verification and Audit Concepts and Principles

There is a functional and a physical attribute to both configuration verification and configuration audit. Configuration verification is an on-going process. The more confidence the Government has in a contractor's configuration verification process, the easier the configuration audit process becomes. The reward for effective release, baselining and configuration/change verification is delivery of a known configuration that is consistent with it's documentation and meets its performance requirements. These are precisely the attributes needed to satisfy the ISO-9000 series requirements for design verification and design validation as well as the ISO 10007 requirement for configuration audit.

6.2.1 Configuration Verification.

Configuration verification is a process that is common to configuration management, systems engineering, design engineering, manufacturing, and quality assurance. It is the means by which a contractor verifies his design solution. The functional aspect of configuration verification encompasses all of the test and demonstrations performed to meet the quality assurance sections of the applicable performance specifications. The tests include verification/qualification tests performed on a selected unit or units of the CI, and repetitive acceptance testing performed on each deliverable CI, or on a sampling from each lot of CIs, as applicable. The physical aspect of configuration verification establishes that the as-built configuration is in conformance with the as-designed configuration. This verification is accomplished by the contractor through physical inspection, process control, or a combination of both.

Once the initial configuration has been verified, approved changes to the configuration must also be verified. **Figure 6-2**, illustrates the elements in the process of implementing an approved change.

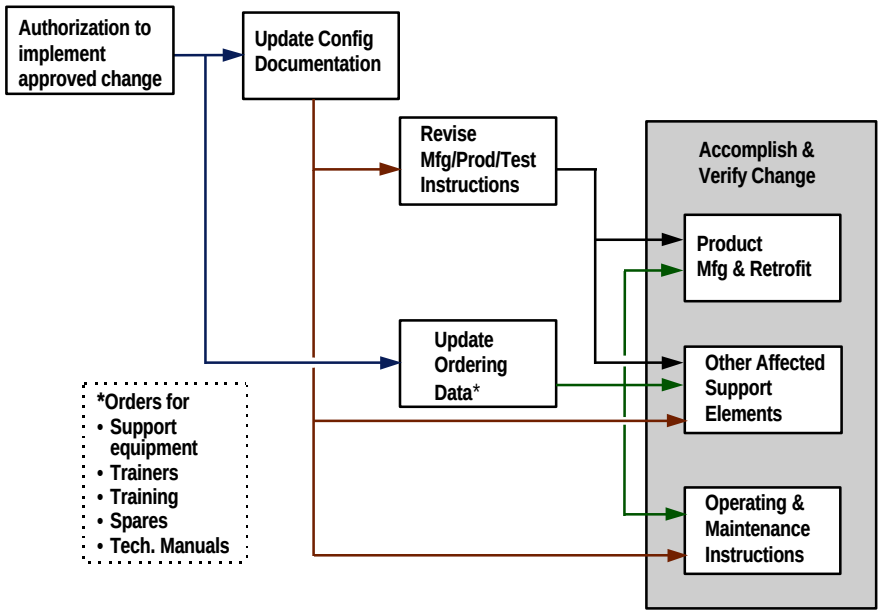

Figure 6-2. Change Implementation and Verification

Change verification may involve a detailed audit, a series of tests, a validation of operation, maintenance, installation, or modification instructions, or a simple inspection. The choice of the appropriate method depends upon the nature of the CI, the complexity of the change, and upon the support commodities that the change impacts. If the change is being introduced into a production line, and all future units will have the change incorporated via the production process, it is normally sufficient to ensure that:

- Manufacturing instructions contain the change and are released for use (as with a work order), and
- The first articles produced are inspected for compliance.

However, if support elements are impacted, or the change requires incremental retrofit to many units, complete implementation and verification of the change can be a lengthy process. Under these circumstances, implementation planning must define the extent to which the change to each unit and support commodity is to be verified; and the records to be maintained. When materials, parts, or retrofit kits are ordered in incremental stages (e.g. per year, per month), the incremental ordering and supply actions should also be verified.

Retrofit changes to organically supported items are verified and reported to the Government's status accounting system by the activity given installation and checkout responsibility for the retrofit. Changes retrofit by the contractor for contractor supported items are verified by the contractor.

6.2.2 Configuration Audit

The dictionary definition of the word "audit" as a final accounting gives some insight into the value of conducting configuration audits. As has been discussed earlier in this handbook, configuration management is used to define and control the configuration baselines for the CIs and the system. In general, a performance specification is used to define the essential performance requirements and constraints that the CI must meet. When the performance specification is baselined, those requirements are contractual, so it is prudent for the Government to ascertain that the contractor has provided the expected performance capabilities. Since the development involves the generation of product documentation, it is prudent to ascertain that the documentation is an accurate representation of the design being delivered. To the extent that the Government is buying the CIs to approved detail specifications, this kind of audit would be performed by the Government. However, the design activity should audit all CIs in the deliverable product. The operation and life cycle support of the CI is based on this documentation. To fail to assure its accuracy can result in acceptance of items that will not perform as specified, or to greatly complicate future logistics support of the CI.

Configuration audits provide the framework, and the detailed requirements, for verifying that the contractor's development effort has successfully achieved all of the requirements specified in the configuration baselines. If there are any problems, it is the auditing activity's responsibility to ensure that all action items are identified, addressed and closed out before the design activity can be deemed to have successfully fullfilled the requirements.

There are three phases to the audit process, and each is very important. The pre-audit part of the process sets the schedule, agenda, facilities and the rules of conduct and identifies the participants for the audit. The actual audit itself is the second phase, and the third is the post-audit phase in which diligent follow-up of the audit action items must take place. For complex products such as major weapon systems, the configuration audit process is a series of incremental audits conducted over a period of time to verify all relevant elements in the weapon system product structure. The process will normally involve audits conducted by prime contractors on subcontracted items at subcontracor facilities with or without Government participation (at Government option) and audits of prime contractor developed items conducted by yhe Government at the contractor's facility. Each item may be subjected to separate functional and physical audits, or both may be conducted at the same time,.

6.2.2.1 Functional Configuration Audit The Functional Configuration Audit (FCA) is used to verify that the actual performance of the CI meets the requirements stated in its performance specification and to verify that the CI has met those requirements. For systems, the FCA is used to verify that the actual performance of the system meets the requirements stated in the system performance specification. In some cases, especially for very large, complex CIs and systems, the audits may be accomplished in increments. Each increment may address a specific functional area of the system/CI and will document any discrepancies that are found in the performance capabilities of that increment. After all of the increments have been completed, a final (summary) FCA may be held to address the status of all of the action items that have been identified by the incremental meetings and to document the status of the FCA in the minutes and certifications. In this way, the audit is effectively accomplished with a minimum of complications.

Although an FCA is only required once for each CI or system, a number of FCA-like activities may be accomplished at other times during the life cycle of the CI or system. Many Class I ECPs incorporate a new design into the baselined design. The performance of each new design element must be verified to ensure that it will not degrade the performance of the CI or system. The degree and type of verification will be included as part of the ECP; it may vary from a simple analysis of the similarity to the old design to a lengthy program of testing similar to the original verification testing accomplished during the EMD phase. However, it is important to understand that a complete retest and FCA are not required for each ECP; only the verifications specified in the ECP are required.

a. A production contract may be issued with the requirement for a "first article" inspection to be accomplished. This would include more comprehensive "testing" than the normal production acceptance tests, and the test data resulting from the "first article" would be subject to a review process not unlike an FCA.

b. An ECP or a new contract may call for the development of a new CI(s) and incorporation of the new CI into the system via a modification program. The expected performance of the new CI would commonly be defined in a performancet specification, and the results of the verification testing of the CI would be checked at an FCA. In addition, some retesting of the existing system elements with the new CI incorporated would normally be required, and those results would also be subject to a review similar to an FCA.

6.2.2.2 Physical Configuration Audit The Physical Configuration Audit (PCA) is used to examine the actual configuration of the CI which is representative of the product configuration in order to verify that the related design documentation matches the design of the deliverable CI. It is also used to validate many of the supporting processes that the contractor uses in the production of the CI. The PCA is also used to verify that any elements of the CI that were redesigned after the completion of the FCA also meet the requirements of the CI's performance specification. In cases where the Government does not plan to control the detail design, it is still essential that the contractor conduct an internal PCA to define the starting point for controlling the production design and to establish a product baseline. Additional PCAs may be accomplished later during CI production if circumstances seem to warrant it. This is most common when the Government controls the CI detail design and:

- The original production line is "shut down" for several years and then production is restarted
- The production contract for manufacture of a CI with a fairly complex, or difficult-to-manufacture, design is awarded to a new contractor.

6.2.2.3 Application of Audits during Life Cycle It is extremely unlikely that FCAs or PCAs will be accomplished during the Concept Exploration and Definition phase or the Program Definition and Risk Reduction phase of the life cycle. Audits are intended to address the acceptability of a final, production-ready design and that is hardly the case for any design developed this early in the life cycle. [NOTE: An activity similar to the FCA or the PCA might be accomplished during the PD&RR phase as a part of the completion of a competitive prototyping effort to facilitate the evaluation of the results of the competition.]

It is during the Engineering and Manufacturing Development (EMD) phase that the final, production and operationally-ready design is developed. Thus, this phase is normally the focus for the auditing activity. Either the Government or the contractor will conduct a PCA for each HW CI that has completed the FCA process to "lock down" the detail design by establishing a product baseline. Hardware CIs built during this phase are sometimes "pre-production prototypes" and are not necessarily representative of the production hardware. Therefore, it is very common for the PCAs to be delayed until early in the Production phase of the program.

Requirements to accomplish FCAs for systems and CIs are included in the Statement of Work (SOW) tasking. The FCA is accomplished to verify that the requirements in the system and CI performance specifications have been achieved in the design. It does not focus on the results of the operational testing that is often accomplished by operational testing organizations in the services. Deficiencies in performance capability, as defined in the baselined specification, result in FCA action items requiring correction without a change to the contract. Deficiencies in the operational capability, as defined in user-prepared need documents, may result in ECPs and/or contract changes to incorporate revised requirements into the baselined specifications or to fund the development of new or revised designs to achieve the operational capability.

Since the final tested software design verified at the FCA normally becomes the production design, the PCAs for CSCIs are normally included as a part of the SOW tasking for the EMD phase. CSCI FCAs and PCAs may be conducted simultaneously to conserve resources and to shorten schedules.

It is normal that the first production units in the Production, Fielding/Deployment and Operational Support Phase would be subjected to a PCA, which depending on whether the acquisition strategy was performance or detailed design based, would be conducted by the Government or by the contractor, respectively This PCA allow the establishment of a Product Baseline for the CI reflecting the design that is being delivered to the field and will require support. From a logistics support standpoint, it is essential that we have an accurate picture of the exact configuration; if we do not, we are likely to buy the wrong spares or to redesign the CI based on inaccurate information, leading to problems in the operation and/or support of the CI.

During a PCA, the deliverable item (hardware or software) is compared to the product configuration documentation to ensure that the documentation matches the design. This ensures that the exact design that will require support is documented. The intent is that an exact record of the configuration will be maintained as various repair and modification actions are completed. The basic goal is sometimes compromised in the actual operation and maintenance environment. Expediency, unauthorized changes, cannibalization, overwork, failure to complete paperwork, and carelessness can cause the record of the configuration of operational software or hardware to become inaccurate. In some situations, a unit cannot be maintained or modified until its configuration is determined. It is necessary to inspect the unit against approved product configuration documentation, as in a PCA, to determine where differences exist. Then the unit can be brought back into conformance with the documentation, or the records corrected to reflect the actual unit configuration.

6.3 Configuration Verification and Audit Activity Guides

Preparation for an audit is as important as the audit itself. **Table 6-1** provides guidance for planning and pre-audit preparation. **Table 6-2** and provides guidance for the conduct of physical and functional configuration audits. **Table 6-3** provides guidance for post-audit follow-up and closeout. **Figure 6-3** describes the content of audit certifications documenting key audit review activities. Refer to **Appendix E** for example certifications.

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Activity Guide: Table 6-1. Audit Planning and Pre-Audit Preparation

Activity	
Responsibility	**Process - Action - Factors - Information**
Government. CM Planning	
Government	• Acquisition strategy for system/CIs is prerequisite to audit plans • Must determine level at which CIs will be acquired to performance or detail requirements; CIs designated for Government control
Request for Proposal	
Government	• State requirements for audit consistent with acquisition strategy
Contractor CM Plan	
Contractor	• Include proposed Government and internal audits; audit process • Expected schedule for audits (keyed to program events)
Scheduling Audits	
Contractor and Government	• Functional/allocated configuration documentation must be approved • Schedule compatible with availability of: items, information, personnel • FCA normally follows expected completion of CI/CSCI verification testing; prior to or concurrent with PCA • PCA requires an article in production (operational) configuration • Incremental HW PCAs typically shadow assembly or test sequence • SW PCA may be delayed until after integration testing • Take manpower constraints into consideration
Audit Planning	
Contractor Preparation, Government Approval	• Global plan & schedule for all FCAs PCAs expanding on CM Plan • CIs/CSCIs to be audited; specific units to be audited • Scope - contract requirements, SOW, specification, approved plans • Location and dates for each audit • Composition of Audit Team: Government, Contractor, Sub-Contractor and their functions in the audit • Documentation to be audited and Reference Material • Administrative Requirements; Security requirements
Audit Agenda	
Contractor, Coordinate with Government	• Covering a specific audit, targeted 60 days before audit • Date, time, location, duration - Unless otherwise specified configuration audits will be conducted at the contractor or a designated sub-contractor facility • Chairpersons: Government and contractor; sub-group chairpersons • Specific CIs or CSCIs • Documentation to be available for review • Chronological schedule for conduct of the audit • Detailed information pertrinent to the audit, e.g. team requirements, facility requirements, administrative information, security requirements
Government Audit Teams	
Government	• Establish MOA between Program and participating agencies who will supply personnel with the requisite functional backgrounds • Assign a Government co-chair for each audit in audit plan • For FCA - Base specific personnel needs on the type and complexity of the CIs to be audited, their technical documentation, and the logistics, training, human factors, safety, producability, deployability, and other requirements of the governing specification • For PCA - experts in engineering design, computer-aided design, engineering release, computer-aided manufacturing, manufacturing, assembly and acceptance test processes are needed. • Task DCMC plant representatives to review and certify engineering release, configuration control and verification processes • Prior to each audit, provide contractor with name, organization, and security clearance of each participating individual on the audit team

Activity Guide: Table 6-1. Audit Planning and Pre-Audit Preparation

Activity	
Responsibility	**Process - Action - Factors - Information**
Contractor Resources and Material	
Contractor	• Audit plan and agenda • Conference rooms • All requests for deviation against the CI, and their status • Minutes of prior audits • Personnel from engineering, manufacturing, and quality assurance • FCA ✓Matrix for each CI identifying specification sections 3 and 4 requirements cross-referencing: – Test plan, procedure and results for each requirement verified by test – Documented results of demonstrations, inspections, analyses verifying requirements ✓Applicable specifications, drawings, schedules, verification test plans and procedures, verification test results, documentation on demonstrations, inspections and analyses • PCA ✓Final draft copy of Configuration Item Detail Specification ✓FCA minutes ✓Engineering drawings, engineering/drafting manuals ✓Isolation of the item(s) (specific serial numbers) to be reviewed ✓Unencumbered access to facilities used for inspection, fabrication, production, assembly, testing ✓Access to all documents referenced by engineering drawings, inspection reports, process sheets and other applicable data ✓Tools and inspection equipment and test software necessary for evaluation and verification

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Activity Guide: Table 6-2. Conducting Configuration Audits

Activity	
Responsibility	**Process - Action - Factors - Information**
Introductory Briefings	
• Government & Contractor co-chairs; • All participants	• Purpose of the audit • Specific items to be audited; pertinent information/characteristics of t the System/CIs • Basic criteria for problemm identification and documentation • Schedule and location of audit events • Teams, team leaders, and location of teams • Administrative procedures for the audit; e.g. problem inputs format. processing flow, audit logistics • Location of necessary facilities
Conduct Reviews. Prepare Audit Findings (Problem write-ups)	
• Audit Sub-Teams: Team leaders	• Sub-teams facilitate the conduct of the audit by enabling parallel effort; auditors assigned to work in area of expertise • **FCA** – Review specification, verification processes and results ✓Test plans/procedures comply with specification requirements ✓Test results, analyses, simulations, etc. verify CI requirements as required by specification ✓ECPs are incorporated and verified ✓Interface requirements verified ✓Configuration documentation reflects configuration of item for which test data are verified ✓Data for items to be provisioned are sampled to assure that they reference applicable performance and test requirements ✓For CSCIs, • Data base, storage allocation, timing and sequencing are in compliance with specified requirements • Software system operation and maintenance documentation [3.4.4, Table 3-9] is complete • Test results and documentation reflect correct software version • Internal QA audits are satisfied – Temporary departures documented by approved Deviation Request • **PCA** – Product baseline ✓Formal examination of the as-built configuration of a CI or CSCI against the specifications and design documentation constituting its product baseline ✓Assure proper parts as refelected in the engineering drawings (see below) are actually installed and correctly marked ✓Determine that the configuration being produced accurately reflects released engineering data – Engineering drawing or CAD representations (design detail) review ✓Representative number of drawings (or CAD representations) and associated manufacturing instructions reviewed for accuracy and to assure that the manufacturing instructions (from which the hardware is built) reflect all design details and include authorized engineering changes • Drawing number and revision on manufacturing instructions matches correct released drawing or CAD representation • Drawing and revisions are correctly represented in release records; drawings do not have more than five unincorporated changes • List of materials on maufacturing instructions matches drawing parts list • Nomenclature, part number and serial number markings are correct • All approved changes have been incorporated • There is a continuity of part references and other characteristics for a major assembly from the top drawing down to the piece part • Required approvals are present ✓**Review the design details relating to any known hazard identified by the system safety**

Activity Guide: Table 6-2. Conducting Configuration Audits

Activity	
Responsibility	**Process - Action - Factors - Information**
	program. [Ref: MIL-STD-882] NOTE: *This may be of particular importance in establishing the "Government Contractor Defense[1]" in liability litigation* ✓Sampling of parts reflected on drawing reviewed to insure compatibility with program parts selection list (or criteria) – Acceptance test procedures and results ✓CI acceptance test data and procedures comply with item specification ✓Acceptance test requirements prescribed by the documentation are adequate for acceptance of production units of a CI ✓CIs being audited pass acceptance tests as reflected in test results – Engineering release and configuration control ✓System is adequate to properly control the processing and release of engineering changes on a continuing basis **[Ref: 3.7.1, 3.7.2, Table 3-12]** ✓Software changes are accurately identified, controlled and tracked to the software and documentation affected – Logistics support plan for pre-operational support ✓Spares and repair parts provisioned prior to PCA are the correct configuration – For CSCIs, ✓Documentation is complete and meets applicable conventions, protocols, coding standards, etc. ✓Software listings reflect design descriptions ✓Delivery media is appropriately marked and in agreement with specification requirements for packaging and delivery ✓Documentation the correct relationship to the components to which the software is to be loaded; For firmware, it contains complete installation and verification requirements ✓Demonstrate that each CSCI can be compiled from library based source code using deliverable or Government owned support assets, and be identical to the CSCI presented for audit and delivery ✓Review operational and support manuals for completeness, correctness and incorporation of comments made at prior reviews (FCA, test readiness, QA audits, etc.) – Examination of proposed DD-250 ✓Accurately reflects the product configuration of the items to be delivered ✓References approved deviation requests for all variances ✓All shortages and un-incorporated design changes are listed • **Problem Write-up** – Originator ✓Identify contract or configuration document ✓Item being audited ✓Requirement ✓Narrative description of the problem/discrepancy ✓Recommendation – Sub-team leader preliminary review ✓preliminary control number assigned ✓approved and signed ✓disapproved ✓returned to originator for revision or further analysis – If approved, forwarded to Executive Panel
Disposition Audit Findings	
• Executive Panel – Audit Chairs	• Executive Panel: – Final review of problem write-ups

[1] One of the tests applied by the courts to determine if the Government and Government contractor are liable is if the Government has participated in the design and has exercised discretion. such activities as design reviews and configuration audits are usefull in documenting the Government's exercise of discretion over the design even though they have basically left the design solution to the contractor under acquisition reform principles

Activity Guide: Table 6-2. Conducting Configuration Audits

Activity	
Responsibility	**Process - Action - Factors - Information**
– Key Govt & Ctr. Personnel – Selected Govt technical experts	– Determine which problem write-ups should be submitted to the contractor – Assign control numbers and enter selected problems into official record of the audit – Submit to contractor with suspense time (typically a period of hours) for responding to the problem
• Contractor	• Contractor response – Concur with problem & recommend action – Offer additional information which resolves or clarifies problem – Disagree with problem finding or contractual obligation
• Originator & Team Leader	• Review response – Determine if it appears to provide satisfactory resolution – Provide to Executive Panel
• Executive Panel: – Key Govt & Contractor personnel	• Disposition all problem write-ups that were submitted to contractor • Make final decision as to further action – Close item – Agree on further actions by Contractor and/or Government necessary to close out problem • Officially record all dispositions, action assignments and suspense dates in audit minutes • Government and Contractor co-chairs sign all problem write-ups
Documenting Audit Results	
• Prepared by Contractor personnel • Signed by Audit co-chairs	• Prepare official audit minutes to include: – Typical meeting minutes: Time, place, purpose, participants, etc. – Action item lists reflecting all actions and suspenses agreed to – Applicable audit certifications documenting key audit review activities **[See Figure 6-3]** ✓Specific Items, systems, documents or processes reviewed ✓Summary of discrepancies/deficiencies in each area referenced to control number of applicable audit problem write-ups (action items) ✓Definitive statements about acceptability or non-acceptability ✓Final status of the contractor's effort in the area being certified

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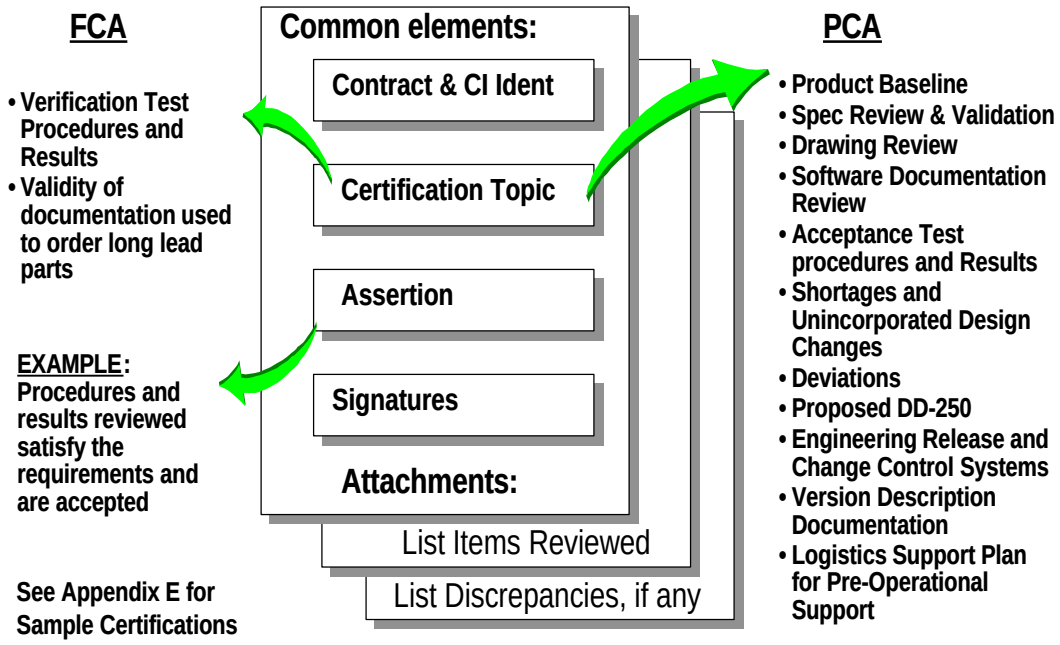

Figure 6-3. Audit Certification Package Content

Activity Guide: Table 6-3. Post Configuration Audit Actions/Audit Close-out

Activity	
Responsibility	**Process - Action - Factors - Information**
Completion of Actions	
Contractor(s) and Govt	• Take appropriate action to complete assigned action items within the designated suspense date • Report completion to audit chairpersons or other designee with objective evidence of completion
Audit co-chairs or their agents	• Periodically query responsible activities concerning status of their audit close-out related action items • Provide periodic report card to Government and Industry Program and Contract offices on progress of completion of all outstanding audit actions • Provide final summary at completion of all open actions